Report from experiment on January 16, 2008: Au^{77+} in RHIC

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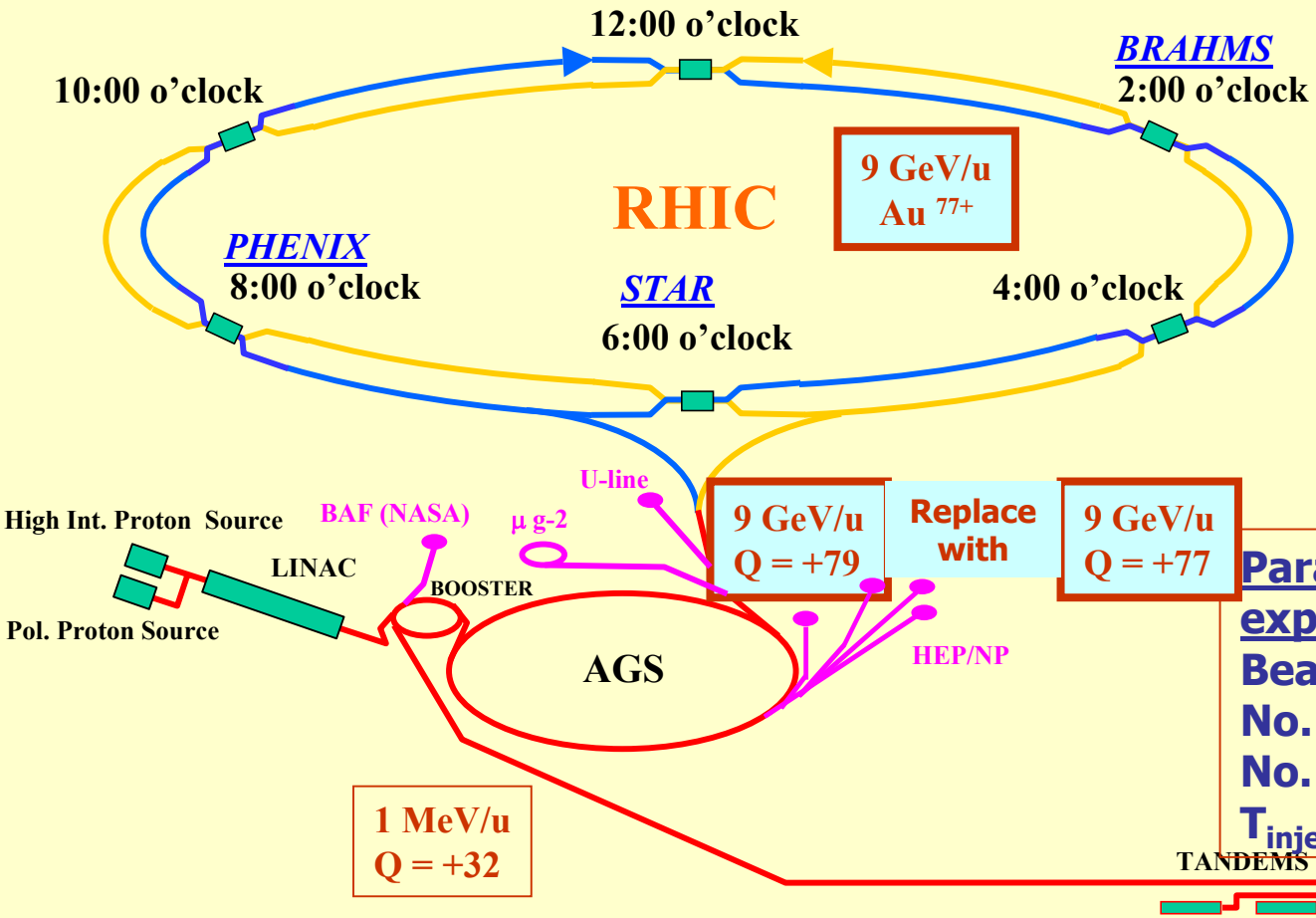
- **Introduction**
  - Remainder: injection of Au^{79+} in RHIC and Au^{77+} extraction in AGS.
  - Area of interest: IBS or beam gas interactions could be possible cooling mechanisms, interest for collisions between not-fully stripped ions in RHIC ?, acceleration of not fully stripped heavy ions?, …
- Participants this evening: Steven Tepikian, William Mackay, Nicholaos Tsoupas, John Butler, Dejan Trbojevic, and Rob Michnoff (from home).
- Details of the vacuum experiment: Titanium sublimation pumps at 8 o' clock : TSP –> CH_4
- Expected photon-decay during beam-gass interaction.

Introduction: Schematic of the experiment



Parameters in the experiment:

Beam Energy ~ 9 GeV/u
No. Bunches = 40?
No. Ions /Bunch = 1 10^9
$T_{injection}$ = 20 minutes

Introduction:

- **Au^{77+} extraction in AGS, stripping @ U-line F2 flag, ATR line tuned for Au^{79+} and injection of in RHIC.**

The rest mass of fully stripped gold $m_{Au}c^2$ =183.4333180 GeV

$$B_{RHIC}\rho_{RHIC} = \frac{A\beta_o\gamma_o}{Zec} m_{amu}c^2 = \frac{197}{79}\frac{\beta_o\gamma_o}{ec} m_{amu}c^2$$

$$B_{AGS}\rho_{AGS} = \frac{A\beta_o\gamma_o}{Zec} m_{amu}c^2 = \frac{197}{77}\frac{\beta_o\gamma_o}{ec} m_{amu}c^2$$

$$\frac{\beta_1\gamma_1}{\beta_o\gamma_o} = \frac{79}{77}$$

$$\frac{B_{AGS\_1}\rho_{AGS\_1}}{B_{AGS\_o}\rho_{AGS\_o}} = \frac{\beta_1\gamma_1}{\beta_o\gamma_o} = \frac{77}{79}$$

- if we fix the $B\rho$ in RHIC and ATR (AGS to RHIC transfer line) only the U – line part and the AGS need adjustments.

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150–350 keV ARGON AND NEON INDUCED X-RAY EMISSION FROM A Mo TARGET *

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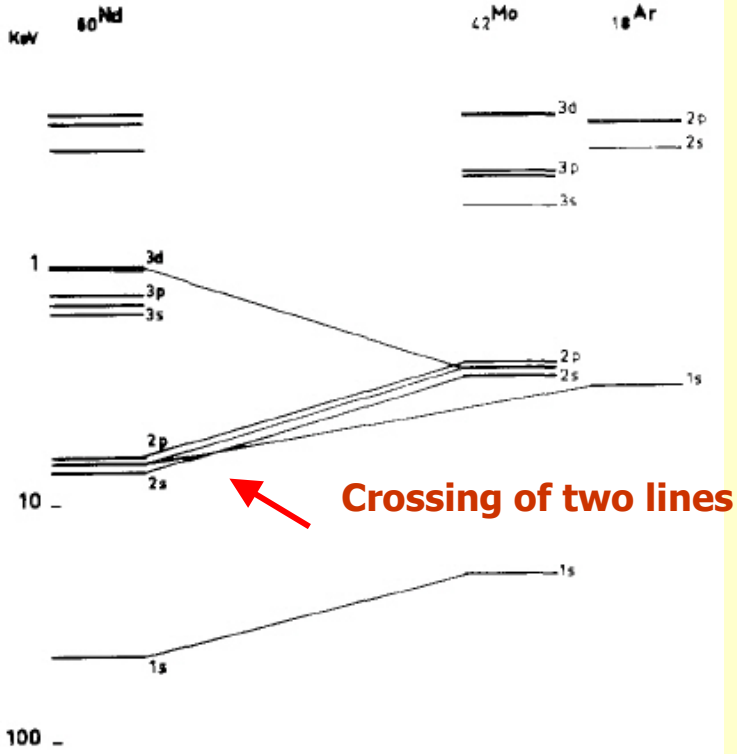
42+18=60 Neodymium



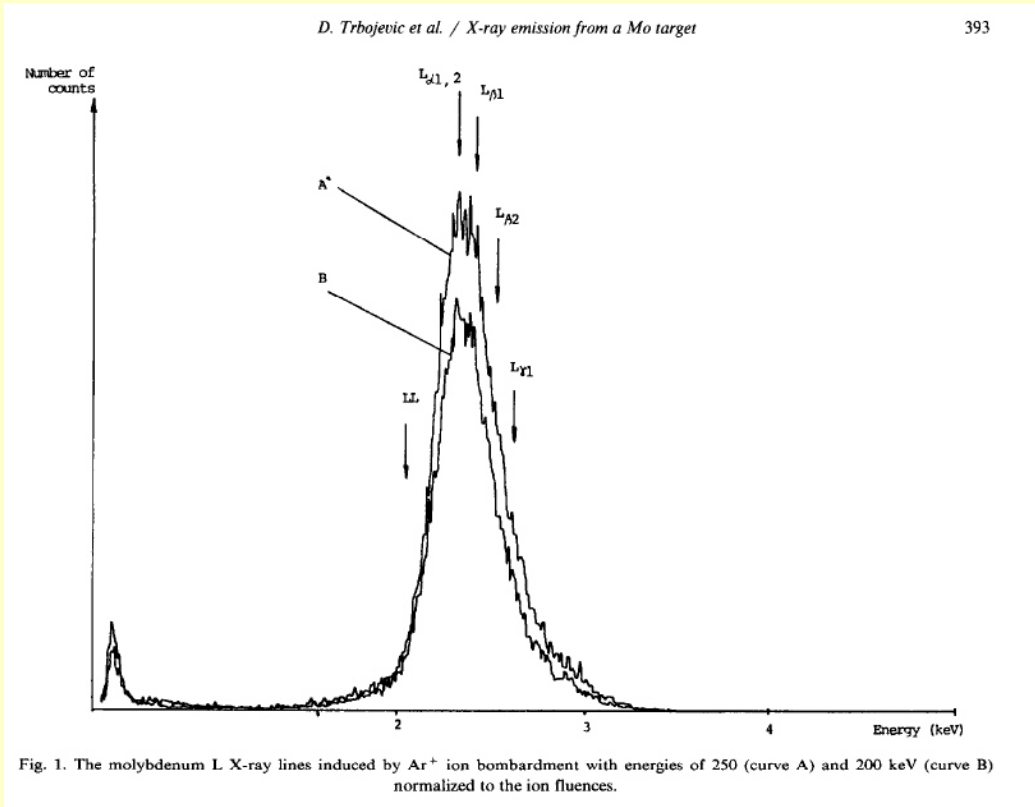


Fig. 1. The molybdenum L X-ray lines induced by Ar^+ ion bombardment with energies of 250 (curve A) and 200 keV (curve B) normalized to the ion fluences.

Collisions of the Helium like Gold ions Au^{+77} with Al target

Experimental set-up

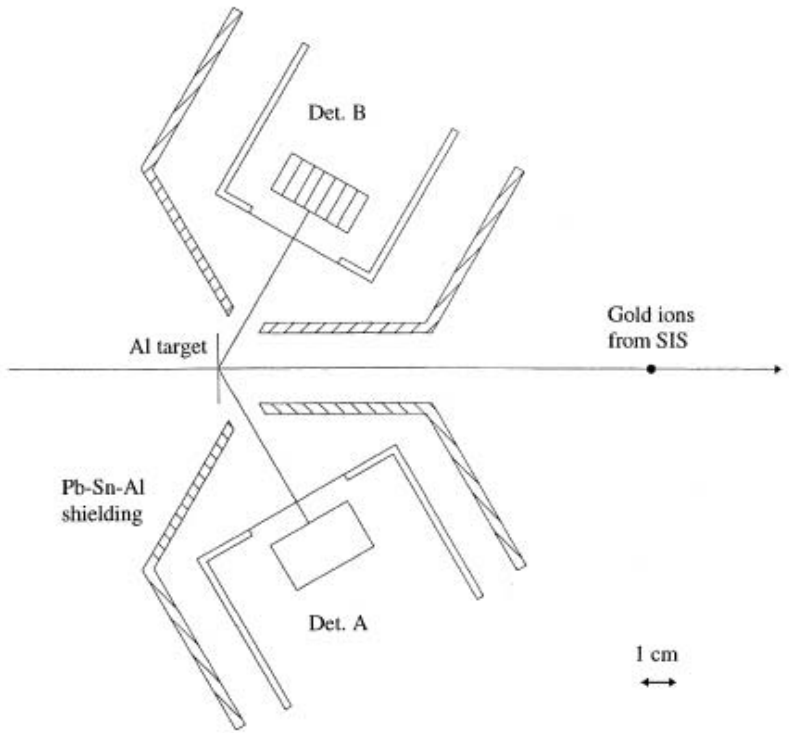


Fig. 2. Experimental setup at the target area.

Two photon decay

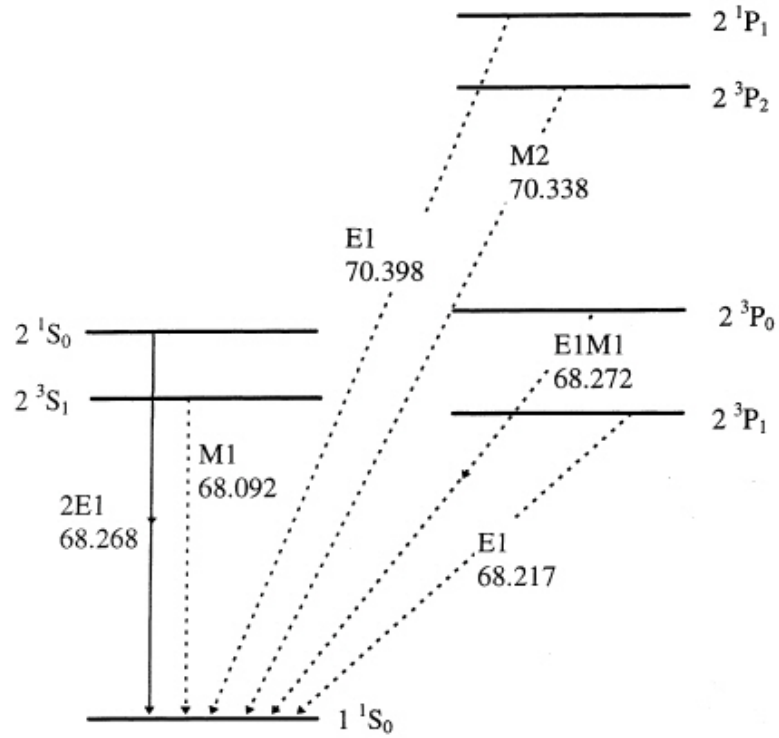


Fig. 1. Level scheme of heliumlike gold including important decay modes. All energies in keV.

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Two photon decay

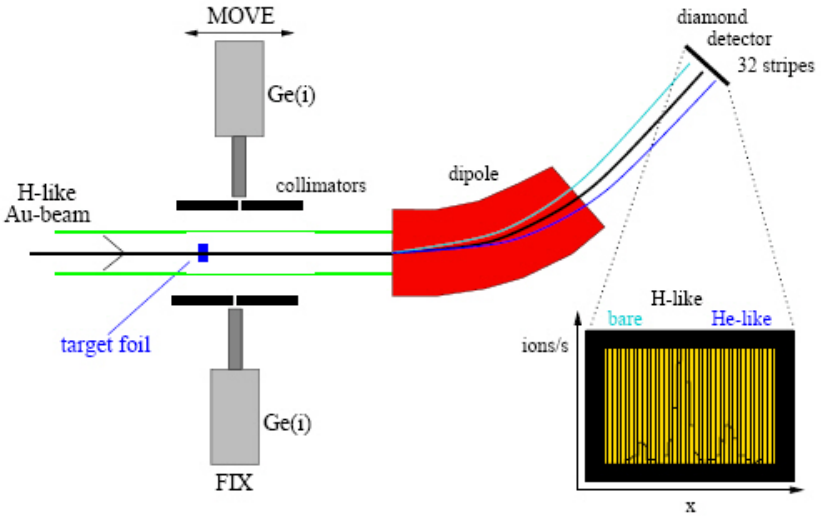


Figure 1: Experimental setup in Cave A.

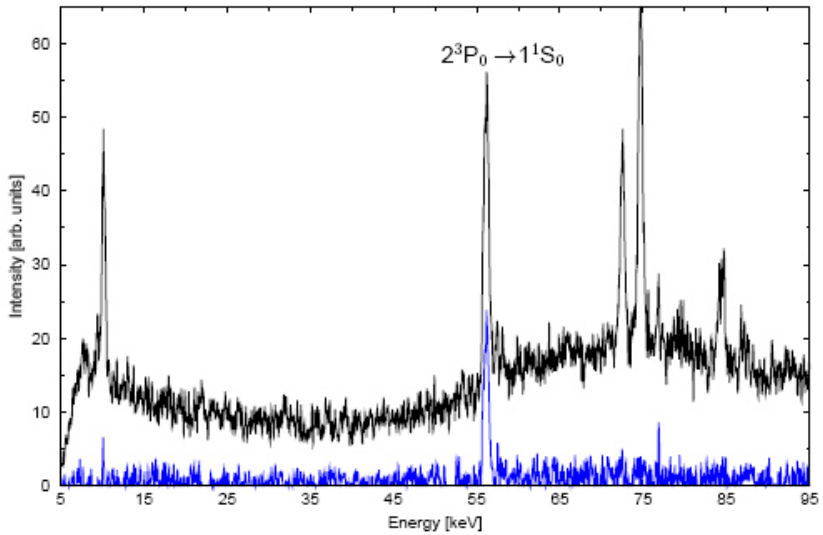
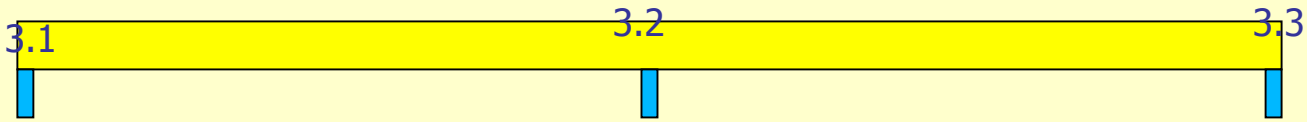


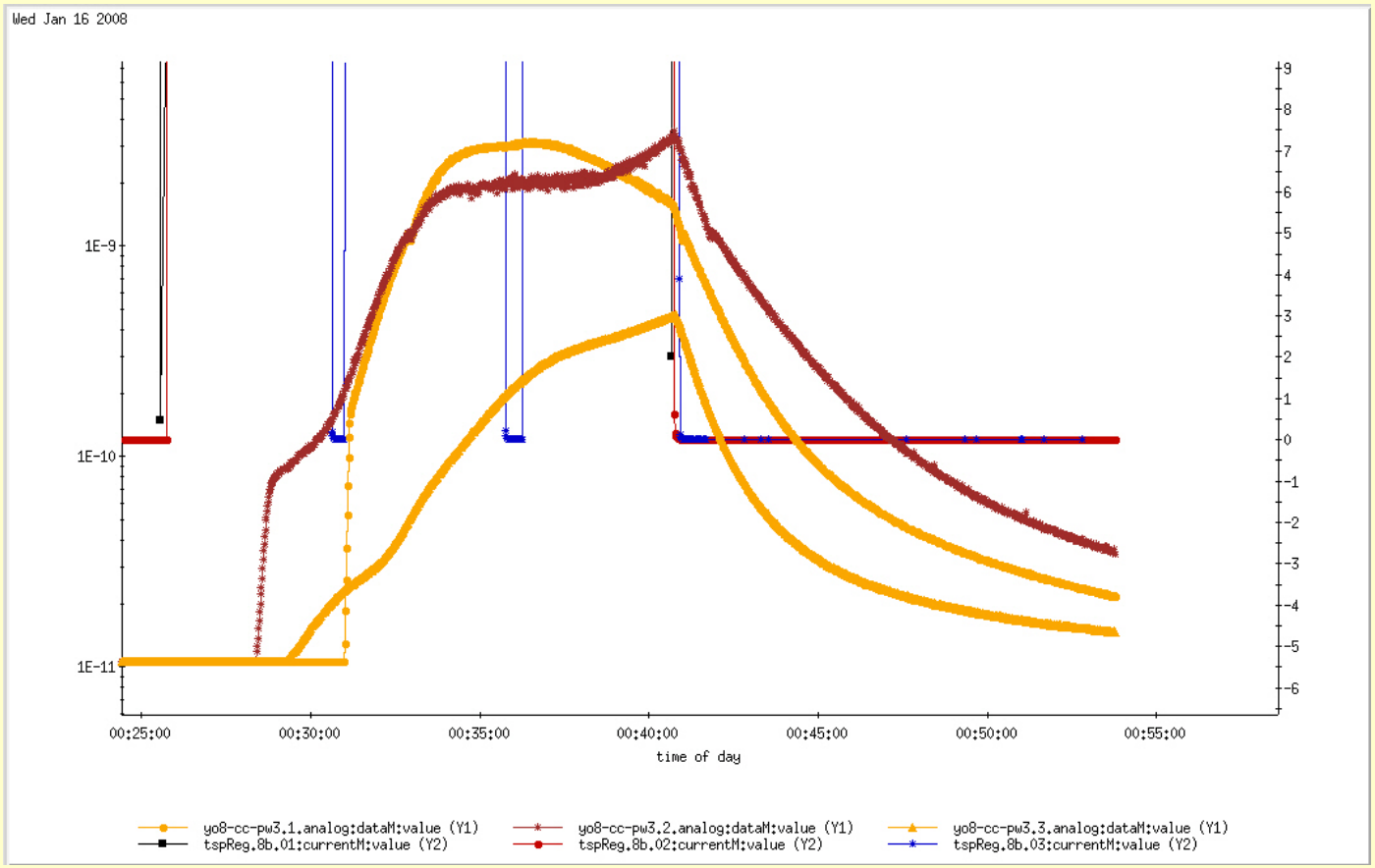
Figure 2: A raw and a coincidence spectrum obtained with the moveable Ge(i) detector.

Collisions of the Helium like Gold ions Au^{+77} with CH_4

Experimental set-up

Two photon decay





Collisions of the Helium like Gold ions Au^{+77} with CH_4

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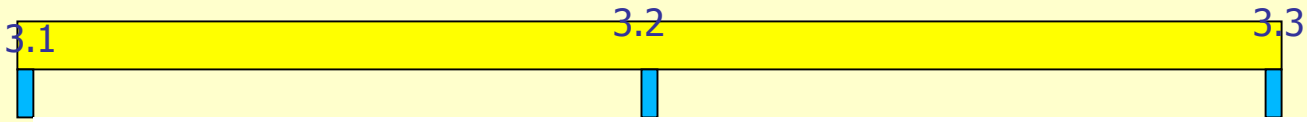

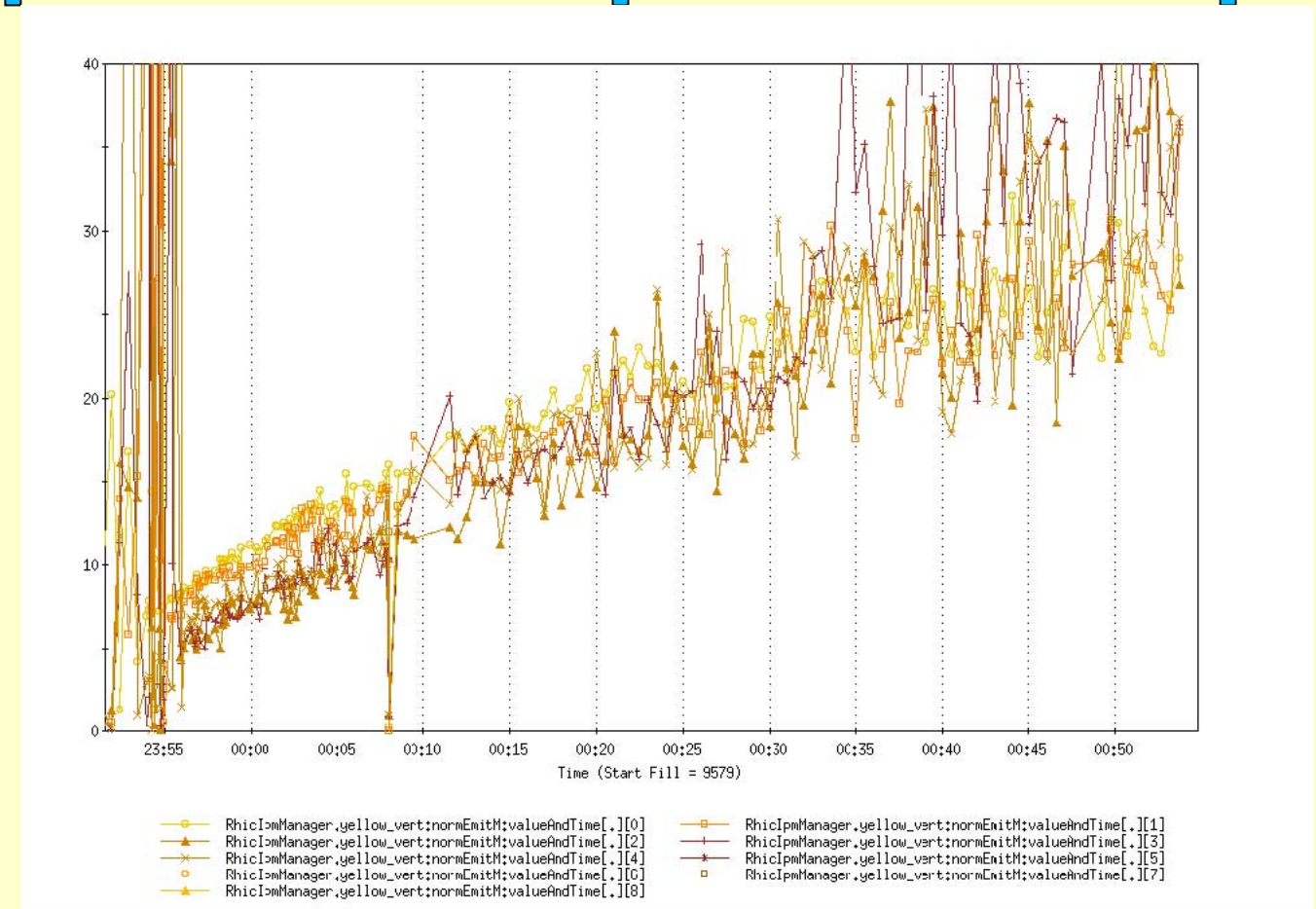

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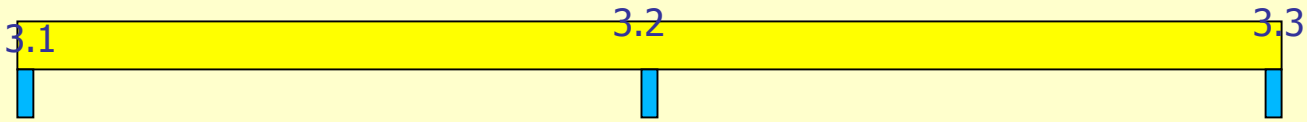
Two photon decay



$$\frac{1}{N}\frac{dN}{dt} = \frac{1}{\tau} = n\, l\, f\, \sigma$$

$$n = 9.656\ 10^{18}\ \frac{p(Torr)}{T}$$

$$f = 78\,kHz$$

$$l \sim 40\,m$$

$$\sigma \sim 2\ 10^{-24}\ cm^2$$

$$\frac{1}{\tau} = 1.43\,10^{-7}\,\frac{1}{s}$$

$$t = 10\ \text{min}$$

$$N\ 8.61\,10^{-5} = \frac{dN}{dT}$$

Summary from the two experiments:

Two experiments with injecting and storing gold ions with two electrons were very successful.

- We have showed that gold ion beams could be stored at RHIC injection energy without any problem.
- The influence of the RF voltage on the Au^{+77} stored beam:
  - has clearly shown worse beam decay with higher voltage, opposite to the expected 'cooling' effect.
  - it is not absolutely clear if the horizontal emittance growth was smaller with higher RF voltage.
- Ion beam intensity dependence on possible cooling has not yet been studied.
- A possible effect of the beam-gas interaction on cooling has not yet been studied.

We need more studies to see if there is a cooling of the gold ions Au^{+77} with two electrons in the AGS.